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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/534,946	05/11/2005	Takashi Yokoyama	94326	3657

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EXAMINER	
SONG, MATTHEW J	

ART UNIT	PAPER NUMBER
1792	

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/534,946	YOKOYAMA ET AL.	
	Examiner	Art Unit	
	Matthew J. Song	1792	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *17 October 2007*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-9,13-16,19 and 21-23* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-9,13-16,19 and 21-23* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/ are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 112

1. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

2. Claim 1-9 and 22-23 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. Claim 1 recites, "V/G1 defining a range of near a critical value in which there is an effect that a size of the void defect becomes smaller, and which is a range that is larger than a critical value of a void defect region and an OSF region". There is no support for the claimed limitations. The original disclosure does not define V/G1 in such terms. The same arguments apply to the remaining claims which incorporate the same limitation.

3. Claim 22-23 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. Claim 22 recites, maintaining the growth condition V/G1 in a range of values of a

pulled silicon crystal. There is no support for this claim. There is only support for maintaining the growth condition near a critical value.

4. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

5. Claim 1-9 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Claim 1 recites, "the silicon crystal is pulled up by lowering a growth condition V/G_1 to near a critical value" in line 3-4. It is unclear what the "critical value" is and how "near" a value needs to be to satisfy the claimed limitation. The same arguments apply to claims 2-9. Also, "a size of a void defect becomes smaller" is indefinite because the limitation "smaller" has no defined relationship with something else. In other words, it is unclear what the size of the void defect is smaller than. In order to expedite prosecution, the limitation is broadly interpreted to mean smaller than the maximum size of the void defect. In regards to the "critical value" void defect becomes smaller does not render the claim definite because it is still unclear when a defect becomes smaller since there is no relationship (i.e. smaller than X). It is also noted that applicant's figures 13A-C show the critical value not at the exact maximum of the curve but at some apparently random value during the downward sloping portion of the curve. Furthermore, it is unclear what a critical value for a void defect region and a OSF region because the specification does not specify what the critical value is.

6. Claims 1-9 and 22-23 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Claim 1 and 22 recites pulling a crystal while maintaining a growth condition V/G1 in (1) a range of values in a region in which voids becomes smaller and (2) is a range of values larger than a value of V/G2. The claim is indefinite because the claim defines V/G1 using two separate ranges of values. The same arguments apply to the remaining claims which incorporate the same limitation.

Claim Rejections - 35 USC § 102

7. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

8. Claims 1, 4 and 22-23 are rejected under 35 U.S.C. 102(b) as being anticipated by Okui et al (US 6,458,204).

Okui et al discloses a method of manufacturing a silicon wafer from a silicon crystal pulled from a silicon melt comprising a boundary between the silicon crystal and the melt during the pulling of the silicon crystal being convex with respect to the melt surface (Abstract, Fig 3b, and col 4, ln 35-65). Okui et al also discloses pulling while maintaining the solid-melt interface in convex shape and temperature distribution effects the shape of the solid-melt interface (col 5,

ln 65 to col 6, ln 15 and col 7, ln 1-15). Okui et al also discloses controlling the axial temperature gradient to obtain a convex shape (col 10, ln 20-40).

Okui et al does not specifically disclose the silicon crystal is pulled by lowering a growth condition V/G_1 to a near critical value defining a range of near a critical value in which there is an effect that a size of a void defect becomes smaller, and which is a range that is larger than a critical value of a void defect region and an OSF region, and in a state in which the axial temperature gradient near the melting point of the crystal is increased and the solid-liquid interface is convex. The claim is indefinite as discussed previously because of the indefinteness of "near." However to expedite prosecution, this feature is interpreted to be inherent to Okui et al because Okui et al discloses forming a convex solid-liquid interface and controlling the axial temperature gradient to obtain the shape at a particular pulling rate, thus necessarily is "near" the critical value. Therefore, the V/G_1 condition claimed by applicant is inherent to Okui et al because Okui et al discloses forming a convex shape and OSF region is present (see claim 2 which depends from claim 1). In regards to the larger than a critical value, Okui et al teaches varying the conditions to produce or not produce a OSF region and defects (Fig 2), thus during the pulling this condition is also satisfied.

Referring to claim 4, Okui et al discloses magnetic field (col 9, ln 15-30).

Referring to claim 22-23, it is noted that the claim uses Jepson language. Thus only the improvement is addressed and all other limitations are admitted prior art. Okui et al teaches varying the pulling rate, which directly affects the V/G ratio, to produce a crystal having a different array of defects and portions which containing a denuded region (Fig 2). In regards to the range of values in a region of the pulled crystal in which a void defect becomes smaller, there

is no relationship for "smaller" as discussed previously, thus the claim is interpreted to mean smaller than a maximum sized void; therefore since Okui teaches denuded region (no defect region) all over the wafer surface (col 4, ln 35-60), the voids are smaller and within the claimed range. In regards to the larger than a V/G2 or smaller than a V/G2, Okui et al teaches varying the conditions to produce or not produce a OSF region and defects (Fig 2), thus during the pulling this condition is also satisfied.

Claim Rejections - 35 USC § 103

9. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

10. Claims 2, 3, 5-6 and 13-16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Okui et al (US 6,458,204) as applied to claims 1 and 4 above, and further in view of Inagaki et al (US 2002/0144641 A1).

Okui et al discloses all of the limitations of claim 2, as discussed previously, except that a cooler is used to cooler the silicon crystal and the growth rate V is from 75-97% of Vmax.

In a method of pulling a silicon single crystal, note entire reference, Inagaki et al teaches as a cooler **19** is disposed within a CZ furnace and an increase in the temperature gradient of the body of the single crystal results in miniaturization of crystalline imperfections ([0184]). Inagaki et al also teaches the rate at which the silicon ingot is to be pulled can be increased and the production efficiency of the ingot can be improved ([0184]).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Okui et al by using the cooler taught by Inagaki et al to increase the temperature gradient and improve productivity by increasing the growth rate.

The combination of Okui et al and Inagaki et al does not teach the growth rate V is from 75-97% of Vmax. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Okui et al and Inagaki et al by optimizing the pulling rate to obtain the claimed pulling rate by conducting routine experimentation to optimize productivity.

Referring to claim 3, the combination of Okui et al and Inagaki et al teaches using a cooler to control the temperature gradient and the temperature gradient effects the convex shape ('641 [0184] and '204 col 10, ln 15-40).

Referring to claim 5, the combination of Okui et al and Inagaki et al teaches using a cooler and controlling rotational speed of the crystal and the rotational speed of the crucible ('204 col 4, ln 35-65).

Referring to claim 6, the combination of Okui et al and Inagaki et al teaches using a cooler and producing a wafer with no OSF defects ('204 Table 1 and 2). The V/G_1 is expected to be near a critical value because a convex shape is obtained in the melt-solid interface and a wafer with no OSF defects is obtained, which is similar to the process taught by applicants.

Referring to claim 13-16, the combination of Okui et al and Inagaki et al teaches a heat shield distance of not less than 50 mm ('204 col 11, ln 55 to col 12, ln 20), which overlaps the claimed range. Overlapping ranges are prima facie obvious (MPEP 2144.05).

11. Claims 7-9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Okui et al (US 6,458,204) in view of Inagaki et al (US 2002/0144641 A1) as applied to claims 2, 3 and 5-6 above, and further in view of Akiyama et al (EP 1137069 A1).

The combination of Okui et al and Inagaki et al teaches all of the limitations of claim 7, as discussed previously, except the claimed oxygen concentration.

In a method of making a wafer from an ingot about by the Czochralski process, note entire reference, Akiyama et al teaches it is preferable to have an oxygen concentration of 18 ppma or less and if the oxygen concentration is low, growth of the crystal defects can be further suppressed ([0090] and [0082]). The conversion of 18 ppma to atoms/cm^3 is $9x10^{17}$ atoms/cm^3, as evidenced by Borgini et al (US 2002/0179006 A1 in paragraph [0022]. Overlapping ranges are held to be *prima facie* obvious (MPEP 2144.05).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Okui et al and Inagaki et al by using a low oxygen concentration, as taught by Akiyama et al, to suppress crystal defects.

Referring to claim 8-9, the combination of Okui et al, Inagaki et al and Akiyama et al teaches annealing at 1100-1300°C in an Ar atmosphere, this clearly suggests applicant's non-oxidative atmosphere, to eliminate defects from the surface of the wafer and producing a wafer with no OSF ('069 [0093] and '204 Table 1).

12. Claims 19 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nakamura et al (WO 01/71069 A1), where US 6,869,478 is used as an accurate English Translation, in view of Falster et al (US 2002/0121238 A1).

Nakamura et al teaches producing a defect free crystal where defect free means no voids defects, nor oxidation induced stacking faults or dislocation clusters ('478 col 14, ln 1-40).

Nakamura et al does not teach setting a carbon concentration to $1x10^{15}$ atoms/cm^3.

In a method of forming silicon single crystals, note entire reference, Falster et al teaches carbon present as an impurity in a single crystal silicon is preferably less than $5x10^{15}$ atoms/cm^3 ([0163]), overlapping ranges are held to be *prima facie* obvious (MPEP 2144.05). Falster et al also teaches carbon has the ability to catalyze into oxygen precipitate nucleation centers so it is preferred to keep carbon low ([0163]).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Nakamura et al by having a low carbon concentration, as taught by Falster

et al, within the claimed range because carbon produces defects thus less carbon is desirable to produce fewer defects.

13. Claim 21 is rejected under 35 U.S.C. 103(a) as being unpatentable over Falster et al (US 2002/0121238 A1) in view of Moriya et al (EP 1162291 A1).

In a method of forming silicon single crystals, note entire reference, Falster et al teaches carbon present as an impurity in a single crystal silicon is preferably less than $5x10^{15}$ atoms/cm^3 ([0163]), overlapping ranges are held to be *prima facie* obvious (MPEP 2144.05). Falster et al also teaches carbon has the ability to catalyze into oxygen precipitate nucleation centers so it is preferred to keep carbon low ([0163]).

Falster et al does not teach positioning the heat shield where a carbon concentration inside the pulled crystal is $3x10^{15}$ atoms/cm^3.

In a method of pulling a silicon single crystal using the Czochralski method, note entire reference, Moriya et al teaches by controlling the relative position of the lower surface of a heat shield, the impurity concentration therein can be made constant ([0004]).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Falster et al by controlling the position of the heat shield as taught by Moriya et al to maintain the carbon concentration within the range desired by Falster et al.

Response to Arguments

14. Applicant's arguments with respect to claims 1-9, 13-16, 19, and 21-23 have been considered but are moot in view of the new ground(s) of rejection.

15. Applicant's arguments filed 10/17/2007 have been fully considered but they are not persuasive.

Applicant argues the Okui does not teach "near a critical value." Near is indefinite as discussed previously. Thus for the purposes of expediting examination, the V/G ratio for creating a convex melt interface taught by Okui is interpreted to be "near" the critical value.

Conclusion

16. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Borgini et al (US 2002/0179006 A1) teaches a wafer may have an oxygen concentration falling anywhere within the range attainable in a CZ process, which is typically about $5x10^{17}$ to about $9x10^{17}$ atoms/cm^3 or about 10 to about 18 ppma ([0022]).

17. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37

CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

18. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J. Song whose telephone number is 571-272-1468. The examiner can normally be reached on M-F 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael Barr can be reached on 571-272-1414. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Matthew J Song
Examiner
Art Unit 1792

MJS
January 4, 2008

/Robert Kunemund/
Robert Kunemund
Primary Examiner
TC 1700